The University of New Hampshire Center of Excellence for Coastal Ocean Observation and Analysis

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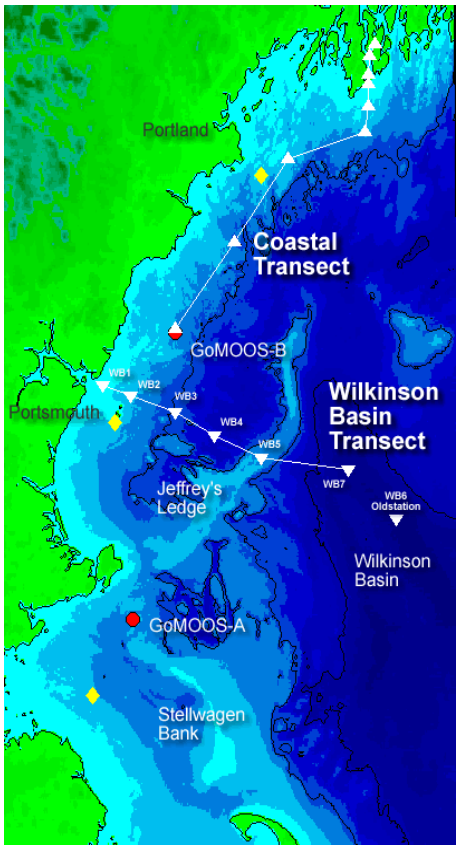
Coastal environments world wide are being degraded through increasing human pressures. In order to understand how these environments are changing and what decisions are needed to manage them at an ecosystem level, an ongoing ecosystem-based monitoring system is necessary. The challenge is to observe and monitor the whole system from the smallest organisms at the base of the food web to the largest predators, and the physical and chemical environment that affects them. This is especially challenging in coastal waters where the currents are strongly influenced by tides, winds, shallow banks, and rivers. High natural variability on hourly to daily time scales makes it difficult to observe and understand change occurring over longer time scales.

The Coastal Observing Center at UNH[1] is working to create a system for monitoring the marine ecosystem in the western Gulf of Maine. Research at the Center is laying the foundation for an observing system with the capability to detect, understand, and ultimately forecast changes in the ecosystem. The system is designed to serve the information needs of fisheries and coastal resource managers, educators, and scientists. The western Gulf of Maine region of interest, shown on the map on the right, is centered at the entrance to Portsmouth Harbor and extends north to the Kennebec River and south to Cape Cod.



Since its establishment in 2002, the Center has achieved national prominence for its achievements in two areas. One is for developing technology capable of addressing exchanges between the land and the ocean, and the other is for developing educational materials that link buoys, boats, and satellites to the K-12 classroom. Progress of the Center through January 2006 is described in this report.

[1] Also known by the acronym COOA.

- **PROGRESS TO DATE**

The three central goals of the Center and related objectives are listed below together with a summary of progress under each objective. More detailed progress reports are included in the Appendix.

Goal #1. Develop and implement an observing system for monitoring the western Gulf of Maine ecosystem.

1.1 Data Acquisition Subsystem: Continue making systematic observations of the lower trophic levels of the pelagic ecosystem and the physical and chemical environment; add rate measurements needed for model parameterization and validation.

Cruises. Beginning in the spring of 2004, we began conducting monthly cruises along two transects (fig. 1) to measure phytoplankton and zooplankton together with physical, optical, and chemical properties of the water. This strategy enables us to assess the influence of rivers, weather, and climate-mediated forcings in controlling the productivity of the western Gulf of Maine. Through the end of January 2006, we have conducted 19 Wilkinson Basin transects and 14 Coastal Transects. Our suite of measurements includes CTD and optical profiles at all stations, and pCO_2, oxygen, beam attenuation, and CDOM and chlorophyll fluorescence collected between stations using a unique flow-through fast-rate equilibrator system. At each station and depth sampled, we collect water for lab analysis of alkalinity, pH, DIC, DOC, DON, nutrients, POC, zooplankton biomass and taxa, phytoplankton pigments, and absorption properties. These ship-based observations provide a baseline for the nutrient and carbon cycles in our coastal waters, and place their variability in the context of ecosystem changes.

One achievement that has gained national recognition is our ability to measure dynamic features such as tidal fronts and river plumes with a custom-built flow-through system. These features move many kilometers in a matter of hours and thus cannot be located and measured adequately by traditional sampling at fixed stations. The flow-through system produces detailed information along a continuous transect while the boat is underway. Flow-through systems are not new, but what is novel about our system is its ability to measure surface water chemistry together with optical properties that are amenable to remote sensing.

The first annual-scale estimate of the cycling of carbon dioxide in the coastal Gulf of Maine has been made with this system. It shows the region to be a net sink of this greenhouse gas at a level exceeding that cited for the Mid-Atlantic Bight.[2] This work is critical to understanding how the U.S. and other coastal regions affect the overall budget of greenhouse gases over the North American continent and the globe. On a more locally relevant issue, this flow-through system allows us to map river plumes and assess their impact on the coastal ecosystem.

[2] Results presented at the Ocean Carbon and Climate Change conference in Woods Hole in Aug. 2005.

In the spring of 2006, we will augment the cruise schedule to sample more frequently during the spring bloom period, and during periods of high discharge and post-storm events. Final permits for use of the ^{14}C primary productivity measurements on the R/V Gulf Challenger have been obtained and measurements will begin this spring. Sampling for *Alexandrium sp.*, the red tide phytoplankton, will also start this spring on all cruises with samples being expressed to Don Anderson's group at Woods Hole Oceanographic Institution (WHOI) for counting the next day. As such we will be part of the Northeast PSP collaborative monitoring effort with results being rapidly disseminated to coastal managers via an email mailing list.

Remote Sensing. We continue to acquire and process MODIS chlorophyll and SST data using the standard algorithms furnished by NASA. We acquire level 2 data from NASA, remap the data to a standard projection (Fig. 2), and composite the data over 8-day periods. The composited data are made available over WebCOAST in a variety of formats that are compatible with commonly used software (e.g., NetCDF, HDF-EOS, etc.). In addition, browse images (jpegs) and movies (mpegs) of all 8-day composites can be viewed or downloaded from WebCOAST.

By relating the chemical properties of rivers with their optical properties, we are developing remote sensing techniques for mapping river plumes from space. We also plan to develop an improved bio-optical algorithm for the Gulf of Maine using the optical and biological data collected on our cruises. Details of these plans may be found in the Appendix.

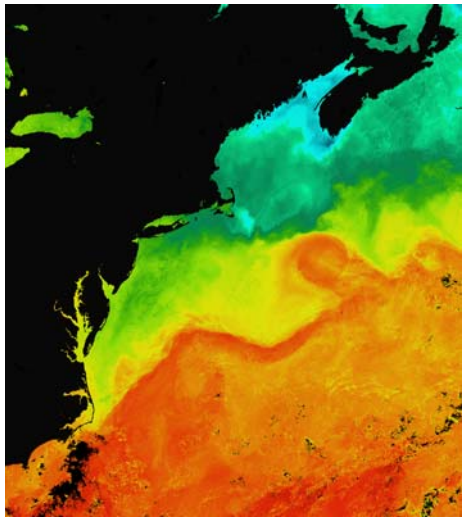


Fig. 2. MODIS SST composite image for September 6-13, 2002 illustrating the standard projection of data that can be downloaded from WebCOAST.

Buoys. A Coastal Buoy project was initiated in 2004 with the goal of developing a reliable system for monitoring estuarine waters that provides data of direct use to stakeholders. Specific objectives were: (1) to develop a readily deployable buoy with a modular backbone, (2) to characterize coastal ecosystem components utilizing recently developed sensor and anti-fouling technology, (3) to provide real-time telemetry to shore by using the latest wireless technology, (4) to implement a shore-based data management system, and (5) to generate useable products through modeling and synthesis and consultation with interested partner groups especially the coastal management and education communities.

The coastal buoy was deployed on April 28, 2005 in the Great Bay Estuary. It was recovered on August 9, redeployed on August 28, and recovered for the season on November 30 to prevent ice damage. The system samples for 10 minutes every half hour, and the data are sent back every hour to a base station at the Jackson Estuarine Laboratory (JEL). For the second deployment of 2005, the instruments were either

swapped with fresh instruments or cleaned and recalibrated. In addition to the standard shutter and wiper, the CDOM fluorometer (ECO-FLCDS, WetLabs Inc.) was equipped with a novel copper face plate as part of the redeployed sensor suite. The addition of the copper face plate greatly improved bio-fouling prevention. During its first deployment, the time series was interrupted once (May 22 to June 2) due to a malfunction of the hard drive on the mooring system manager. A summary of the buoy results is provided in the Appendix.

In addition to our own coastal buoy, the Center has provided funds to GoMOOS to support two buoys, nominally buoys B and C which are visited on our monthly cruises. Initially, plans were to re-locate one of the buoys, but after discussion with users of GoMOOS buoy data, the GoMOOS Board has decided not to move a buoy. The Center also serves data from the *Open Ocean Aquaculture* buoy located 1.8 km south of the Isle of Shoals. Monitoring data from this buoy include temperature, salinity, and dissolved oxygen. Data are collected at three depths every 15-minutes.

New sensors. Last year we began development of a field sensor based on *Molecular Imprinted Polymer* (MIP) technology to detect saxitoxin in the marine environment. In laboratory work to date, caffeine has been used as an analyte of saxitoxin due to the intrinsic toxicity of the latter. A MIP sensing technology has been developed capable of detecting very low levels (500 ppb) of caffeine. We expect saxitoxin MIPs to provide a very fast answer (within minutes) with light, portable equipment, allowing the detection of saxitoxin at a level comparable to the HPLC method. A progress report on this is included in the Appendix.

We continue to work with a new measurement technique related to net ecosystem metabolism and its evolution via measurement of total dissolved gas pressure in surface waters. In summer and fall of 2005, we deployed a flo-thru version of the Pro Oceanus Inc. *gas tension device*. This is a sensor for measuring the total pressure of dissolved gas in seawater. When used in combination with precise oxygen measurements this tool allows us to track the partial pressure of nitrogen gas, an inert tracer of water mass and air-sea mixing. These data are being collected and evaluated by UNH graduate student T. Brown to determine if this GTD technique can provide added quantitative measures of the controls (both physical and biological) on oxygen utilization. If proven successful, we can effectively determine the net metabolism in the near surface waters by tracking CO_2, oxygen and nitrogen levels. This work is being done in collaboration with Prof. Craig McNeil at the University of Rhode Island, a developer of this sensor. We expect a completed Master's thesis by September 2006 based on an extended time series of GTD data collected at the UNH Coastal Marine Laboratory (Dec. 2005- April 2006).

Biochemical tracers. Protocols have been developed for the collection and analysis of caffeine and a suite of lignin phenols. Lignin phenol oxidation products are tracers of dissolved organic matter (DOM) from the land since lignin is a woody substance found only in land plants (Opsahl and Benner, 1996). Caffeine is widely accepted as being a reliable marker of human activity (Siegener and Chen, 2002). Analysis of caffeine was carried out on test samples with nanomolar precision. In the spring 2006, we will carry

out an extensive campaign for caffeine sampling in 5 Gulf of Maine rivers and their plumes. These samples will be analyzed at Dr. Jerome Claverie's Lab. The results should enable tracking of water sources influenced by human activity. We have developed the protocols and purchased lab-ware for lignin phenol analysis, but we are not planning on collection until August 2006 in accordance with the timeline proposed for these analyses.

1.2 *Modeling and Analysis Subsystem: Develop a hierarchy of models as a quantitative tool for investigating the effects of environmental variability on key planktonic species; develop satellite remote sensing algorithms tailored for our region to map primary productivity, trace river plumes, and index water quality and metabolic state.*

This goal involves two classes of models. One involves a system of linked models for forecasting environmental conditions for recruitment of commercially important fish and invertebrate species in the Western Gulf of Maine. The second involves the development of models that employ satellite data to map properties of the ecosystem as it is affected by terrestrial influences. Progress in both areas is described here.

System of linked models. We have subcontracted to Dr. Fai Chai and the modeling group at the University of Maine to develop a *biogeochemical model* for the Gulf of Maine that is coupled to the GoMOOS circulation nowcast/forecast system. This model of the nutrient, phytoplankton, micro-, and mesozooplankton distributions is based on a pre-existing model (e.g. Chai et al., 2002; 2003) that has been modified and adjusted for the Gulf of Maine. Dr. Chai and the modeling group at the University of Maine have made progress in developing and testing the coupled model. It has been fully coupled with the GoMOOS circulation nowcast/forecast system for the Gulf of Maine, and its parameters have been adjusted based upon the observational data provided by COOA and other field programs. They have also processed some historical nutrient data for the Gulf of Maine, which have been used for the model evaluation. The coupled physical-biogeochemical model has been used to produce daily nutrient and chlorophyll fields for the period of January 2002 to June 2006. The model reproduces many observed features, including the spring phytoplankton bloom for most parts of the Gulf of Maine. However, the model fails to reproduce the fall phytoplankton bloom. They evaluated several different schemes for solving advection processes in the model, and found that the different schemes produce different vertical structure of nutrient fields. Thus, the biogeochemical model results are very sensitive to different advection schemes. The rate of nutrient supplied in the fall, highly related to the treatment of vertical advection, determines the magnitude and timing of fall phytoplankton blooms. They are in the process of comparing three different advection schemes, and will decide on one that will become the base model simulation. They plan to present preliminary results at the Ocean Sciences Meeting in February in Hawaii. A manuscript has been outlined, and will be submitted by the end of October 2006.

An *Individual Based (particle tracking) Model* is being developed by a post-doctoral research associate, Dr. Martin Huret, in collaboration with Dr. C. Chen at SMAST, University of Massachusetts, Dartmouth. Dr. Huret worked previously on coupled

biophysical models at CNRS and IFREMER in France. He began working in August 2005 on the Finite Volume Coastal Ocean Model (FVCOM) developed by Professor Chen. He spent the first three months learning the FVCOM and discussing the simulation experiment protocols with Dr. Jeffrey Runge during regular meetings at UNH. The model was then used to simulate the trajectory of fish eggs and larvae spawned in coastal areas off Maine and New Hampshire using recorded wind data for different years. Simulations of larval transport during spring and early summer periods of peak spawning provide indications of years when environmental conditions are favorable (Fig. 3). These studies will inform management strategies aimed at recovering cod stocks in our region. Cod populations have not recovered from critically low levels despite aggressive management strategies.

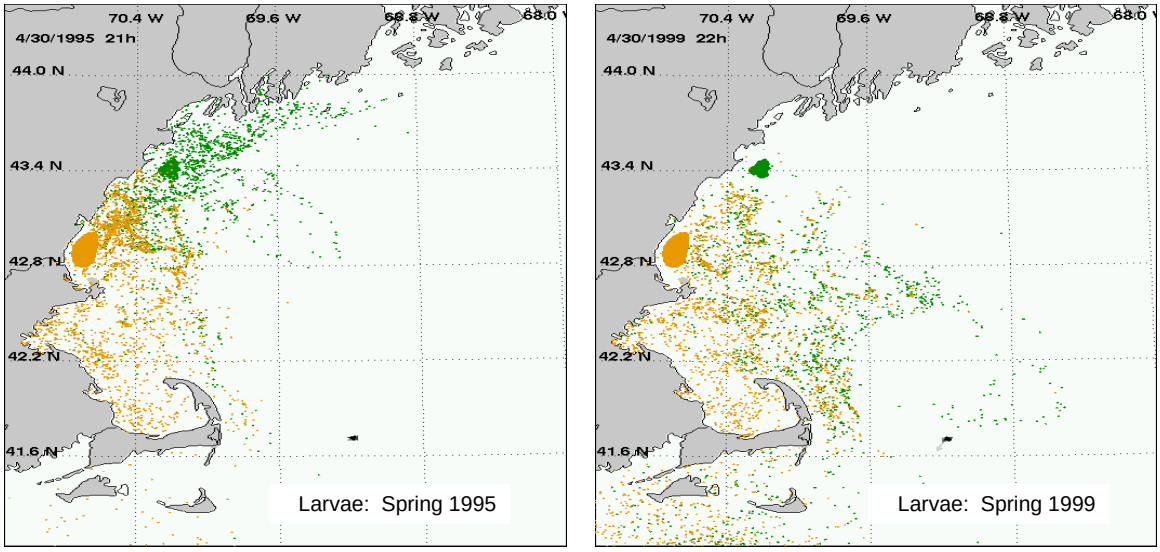


Fig. 3 – These figures illustrate how variable wind and circulation can have large influences on the fate and transport of larvae. In these simulations, a much larger proportion of surface layer particles were retained in the western Gulf of Maine in 1995 compared with 1999.

Terrestrial influences. A *Kennebec Model* has been developed by Huijie Xue through our subcontract with the University of Maine's modeling group. It presently operates at a temporal resolution of 3h and a spatial resolution of 300m at 22 depths. The model has been run using input data (winds, discharge, etc.) for 2004, and we plan to produce runs for 2003, and 2005 to the present. Data acquired along our Coastal Transect and from GOMOOS buoy B will be instrumental in validation efforts. Output from this model is being used in conjunction with algorithms developed from our *in situ* sampling to predict carbon cycle dynamics as river plumes interact with the coastal shelf waters. A paper on this was presented at the Joint OCCC/NACP Coastal Ocean Carbon Workshop, Boulder CO, in September 2005 (Salisbury et al. 2005).

1.3 *<u>Data Management and Distribution Subsystem</u>: Maintain and enhance WebCOAST as the portal for all data and information products produced by the Center.*

Data collections housed in and distributed by WebCOAST are updated as new data become available. Current collections include data from the cruises, MODIS 8-day composites of chlorophyll and temperature, data from the Great Bay coastal buoy, Fleetlink data from sensors onboard fishing and research vessels, and data contributed by other projects, including the *Open Ocean Aquaculture* buoy and the *Great Bay Coast Watch* (GBCW) project. WebCOAST metrics on the number of page hits and volume of data distributed may be found on the WebCOAST website (Fig. 4).

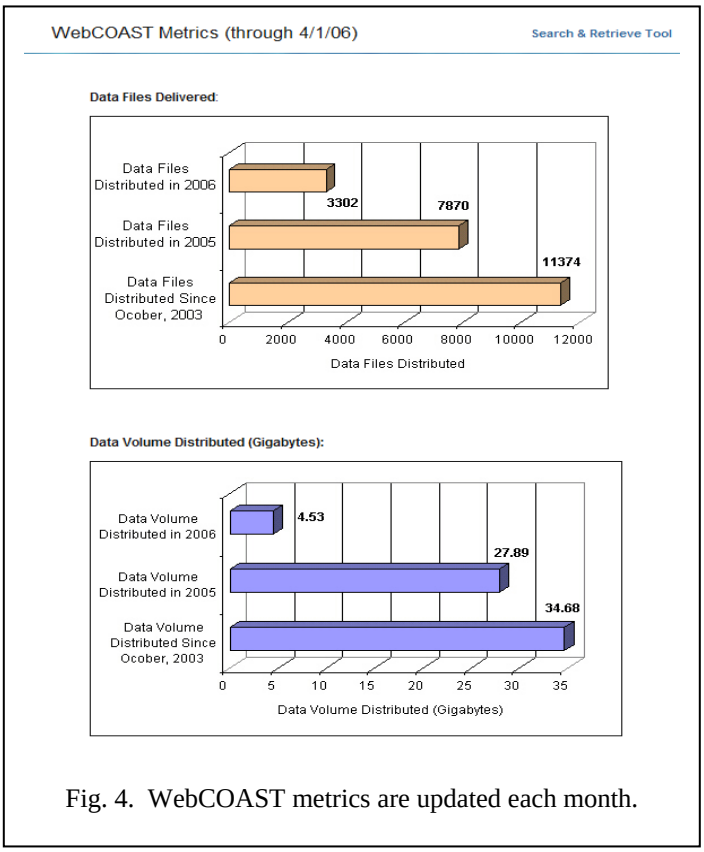


Fig. 4. WebCOAST metrics are updated each month.

Site additions, improvements, and modifications. The cruise data web crawler has been refined with added capability to automatically link to any browse images and make them viewable over the web. In addition, an automatically updated web page for the Coastal Buoy was created during this reporting period. As new data are posted (about every hour), the system generates an updated web page.

Hardware. A DLT tape backup system was purchased and is now in operation. RAID disks are backed up to tape whenever new data are added.

Goal #2. Promote and facilitate the use of coastal ocean observing data and information by resource managers, educators, scientists, and NOAA forecasters and forecast modelers.

2.1 *Engage fisheries stakeholders in the design of models that can be used as tools for decision making and obtain feedback from this community to improve the utility of these models.*

With additional support from the UNH outreach scholarship fund, J. Runge has entered into collaboration with the Northwest Atlantic Marine Alliance (NAMA), a Gulf of Maine organization of fishermen. The purpose of this project, entitled the "Western Gulf

of Maine Inshore Fisheries-Ecosystems Project" is to bring fishermen and researchers into a two-way dialog about incorporating understanding of Gulf of Maine ecosystem variability into ecosystem-based management. During this reporting period, the third of a series of workshops was held in which fishermen met with scientists and managers. A progress report describing results of the Inshore Fisheries-Ecosystems project was submitted to the UNH Vice President's Office Outreach Scholar Program in October 2005. Information sheets describing food web interactions and cod spawning and nursery areas in the western Gulf of Maine are in preparation for distribution to fishermen and members of the New England Fisheries Management Council. Dr. Runge will again participate in the Maine Fishermen's Forum in March of this year to demonstrate the modeling work that is supported by this Center.

This engagement of the fisheries stakeholders serves not only to inform the fishing community of the Gulf of Maine Ocean Observing System and the role of the Coastal Observing Center, but also taps the considerable knowledge base in that community for important information about the location of spawning areas and habitats of the local harvested resources. We see this exchange as vital to a communication process that is needed to assure the utility of the Observing System to this user group.

2.2 Engage coastal resource managers in the design of data and information products derived from coastal observing data to help them assess water quality and other environmental variables and trends.

In our previous progress report, we described an effective method for visualizing our buoy data in the context of historic time series of water quality data collected from Great Bay. Details of this are included here in the Great Bay buoy progress report in the Appendix. This method of visualization was introduced on the Coastal Buoy website during this reporting period, and presented in two talks given by Dr. Ru Morrison at the Estuarine Research Foundation Conference in Norfolk, VA.

We completed a final version of the *"Gulf of Maine Monitoring Programs"* searchable data catalog in collaboration with the Gulf of Maine Council on the Marine Environment (GOMC). The system was demonstrated at the Council's annual meeting in December, 2005 and released publicly shortly thereafter on websites.[3] We are continuing to work with the Council to fine-tune the system to meet their needs.

2.3 Develop resources and offer training to enable educators to utilize coastal observing data in formal and informal settings.

Under the outstanding leadership of Amy Holt Cline, our Center's education and outreach coordinator, we have become nationally recognized as a Center of Excellence for the development of educational materials associated with ocean observing systems. A

[3] Gulf of Maine Council's Home Page: http://www.gulfofmaine.org/; Monitoring Programs Home Page: http://gomc.sr.unh.edu/index.jsp.

visit to the education pages of our website[4] tells this story much better than a few short paragraphs here. Amy Cline now serves on several national steering committees aimed at exploiting observing systems for use in K-12 science curricula. Most recently, she was elected to serve on the ORION Education and Public Awareness Committee (EPAC). Last September, she gave an invited talk at the MTS/IEEE Oceans 2005 Conference on "Preparing Educators with Practical Science: Ocean Observing in the Classroom," and contributed a paper to the published proceedings of that conference (Cline *et al*. 2006). She has also organized special sessions on this topic at national science meetings including one at the upcoming Ocean Sciences Meeting in Honolulu in February 2006.

Team members Denise Blaha and Amy Cline authored a chapter for the *Earth Exploration Toolbook* [5] which has received wide acclaim since its release in September 2004. The chapter, entitled "When is Dinner Served? Predicting the Spring Phyto-plankton Bloom in the Gulf of Maine," provides step-by-step instructions for educators and students to investigate phytoplankton and their role in the Earth system using data from both WebCOAST and GoMOOS. The *Earth Exploration Toolbook* is a project funded by NSF that connects teachers with on-line sources of Earth science data. The chapter was designated a "Teachers' Top Web Pick" for May 2005 on the Sea Grant Ocean Sciences Education website[6] and was mentioned recently in the NetWatch section of *Science* (Dec 2 2005, vol 310, p. 1401). The chapter will be demonstrated at the National Science Teachers Association conference in Anaheim, California in April 2006, and at the regional NSTA meeting in Baltimore, Maryland in November 2006. In collaboration with Annette deCharon of the Bigelow Laboratory (who is P.I.) we recently received funding from NSF to establish a new Center of Ocean Science Education Excellence (COSEE) focusing on the ocean's role in the Earth-Sun system. Our success in this highly competitive round of proposals is largely attributable to the demonstrated excellence of our Center's educational outreach program.

Goal #3. Complement and enhance national / regional expertise in coastal ocean observing.

3.1 At the regional level, participate as an active member of the Gulf of Maine Ocean Data Partnership, and remain active in the establishment of the Northeast Regional Association of Coastal Ocean Observing Systems.

The Coastal Observing Center is an active participant in regional observing system activities. The COOA director, Janet Campbell, is a member of the Board of Directors of GoMOOS, and is currently serving as one of its vice presidents. She is also a co-investigator on a planning grant to form the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS). In the Gulf of Maine Ocean Data Partnership, COOA is represented by Janet Campbell and Annette Schloss. Janet serves on their Governance working group and Annette on their Technology working group.

[4] http://www.cooa.unh.edu/education.jsp
[5] http://serc.carleton.edu/eet/phytoplankton/
[6] http://www.vims.edu/bridge/

3.2 At the national level, continue to serve on the National Federation of Regional Associations Organizing Committee and various working groups for NOAA's Coastal Ocean Technology System.

Janet Campbell was initially one of two representatives from the northeast on the National Federation of Regional Associations (NFRA) Organizing Committee. She has asked Ru Morrison to replace her on this committee. He attended the NFRA meeting in September 2005, and has been a participant in monthly conference calls.

Janet Campbell is chairing a steering committee from the NFRA to plan a workshop to define and document the needs of coastal observing systems for remote sensing data. This workshop will be held at the New England Center in Durham, NH, on October 3-5, 2006. It is being jointly supported by NOAA and NASA through a subcontract to Oceans.US. Each regional association has been asked to name two representatives to attend the workshop.

3.3 Publish our observational data, using common data management standards and protocols, in a machine-to-machine interoperable, web-enabled environment that will allow arbitrary users to discover, retrieve, extract, or parse the data and transport it to another computer.

WebCOAST is our data portal. We are serving data that reside on our own computers as well as data from the JGOFS site at Woods Hole Oceanographic Institution. Data collections are now updated either manually (such as satellite data or Great Bay Coast Watch) or automatically by way of a web crawler (cruise data). We are currently working out plans for adding the near-real time data from the *Open Ocean Aquaculture* buoy to WebCOAST. Metadata are posted on U.S. and Canadian data discovery portals.[7]

3.4 Develop and implement a strategic plan for sustained, long-term observations of the western Gulf of Maine ecosystem serving the needs of fisheries and coastal resource managers, educators and scientists.

The workshop report for the RARGOM theme session on modeling needs related to the regional observing system in the Gulf of Maine was completed in December, 2005. The report contains short articles/ abstracts by plenary speakers, meeting reports on the management-research connection in relation to the observing system, data needs and critical issues for models in the context of the observing system. The report also presents visions and roles of a regional modeling center, and recommendations and research priorities. The report can be accessed on the RARGOM web site.[8]

A meeting of Center personnel involved in modeling activities was held at UNH on January 20, 2006. Discussion topics were COOA's modeling role, the modeling components and modeling on the Center's web page. It was agreed that COOA's function

[7] NASA's Global Change Master Directory (http://gcmd.nasa.gov) and the Canadian Geospatial Data Infrastructure (http://www.geoconnections.org).
[8] The Regional Association for Research on the Gulf of Maine website is: http://www.rargom.org.

is to take the middle ground between research and management needs. The Center will facilitate the development of models to interpret observing data and explore them for applications with users through a process of information exchange. One suggestion was to invite one manager to each modeling meeting and focus on identifying intersections between models and the manager's decision needs. Another suggestion for information exchange was to initiate a rotating seminar series on how to do ecosystem-based management and what information is needed to flow into this process.

Appended to this report are the progress reports of the individual projects led by COOA co-investigators.

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- **CHANGES IN THE WORK PLAN**

No significant changes have been made to the FY05 activities described in the Project Description of the two-year proposal (FY05-06) submitted in the spring of 2005. In our proposal submitted in December 2005 for FY06 funding, two structural changes were proposed. The first change concerns a splitting off of the bio-optical algorithm work into a separate "Remote Sensing" project under the direction of Janet Campbell. The second change involves a reduction in the budget for the Coastal Carbon Time Series project made possible by the establishment of the NOAA/UNH Joint Center for Ocean Observing Technology.

Our bio-optical algorithm development has fallen behind its original schedule since the departure of Mark Dowell in 2004. This work previously was part of the CoMPOSE project which is aimed at developing a primary productivity algorithm for our region. It requires field data to parameterize a model relating water reflectance to the optically active constituents in the water column. Ru Morrison took over for Mark Dowell as P.I. of CoMPOSE, while at the same time he has been responsible for the field surveys (monthly cruises), all bio-optical measurements made at sea and in the laboratory, and the design and deployment of a coastal buoy in Great Bay. Ru is also actively engaged in a number of outreach efforts through the Seacoast Science Center and elsewhere. The goals of the CoMPOSE project have not changed, and Ru will continue as P.I., but to accomplish its goals, we need a person who will be responsible for organizing the field data into a relational database that can then be accessed by other members of the COOA team. The biological and optical data collected on the cruises are essential to the parameterization of a bio-optical algorithm. We propose to hire a new person under the Remote Sensing project to create the relational database.

- **KEY PERSONNEL**

Ann Bucklin left UNH at the beginning of July 2005. Her responsibilities under COOA included the zooplankton assemblage analyses, and she acted as the UNH contact for the Fleetlink subcontract to WHOI. Ann Bucklin supervised Chris Manning who actually carried out the zooplankton analyses. Chris continues to be supported by COOA for this work. The zooplankton time series generated by REACH is continued by COOA's sampling efforts at two former REACH stations (A and D). Other data collected by the REACH program (such as chlorophyll, nutrients, *Alexandrium* cell counts, and CTD profiles) are also still included in the COOA field program.

Doug Vandemark was hired in the fall of 2005 as a Research Associate Professor. Previously he worked at UNH as a visiting scientist from NASA Goddard Space Flight Center. Doug is taking over full responsibility for the Center's Coastal Carbon Time Series project (see Appendix). He will also have a lead role in the creation of the Appledore Island Observatory supported by the Joint Center for Ocean Observing Technology.

UNH Center for Coastal Ocean Observation and Analysis

Janet Campbell, Principal Investigator

Progress Report – February 28, 2006

Appendix

Coastal Marine Primary Production Observing System (CoMPOSe)

J. Ru Morrison, Principal Investigator

Progress Report – January, 2006

The goal of the CoMPOSe project of the Coastal Ocean Observation and Analysis center at UNH is to quantify and understand the variability in the primary productivity of the Gulf of Maine. The synergistic use of both remotely sensed and *in situ* data is essential to capture the processes on the scales, from the quantum to oceanographic basin, important in controlling primary productivity. Currently phytoplankton physiological measurements are only possible from ship platforms while remote sensing platforms allow synoptic assessment of phytoplankton surface distributions.

Progress to date –

Fieldwork – We have continued to expand the bio-optical dataset on the regular monitoring cruises with measurements of inherent and apparent optical as well as biogeochemical properties necessary for remote sensing validation and algorithm development. These continued measurements have enabled us to study the temporal and spatial variability of these properties. For example, we have shown that it is possible to obtain absorption spectra associated phytoplankton pigment assemblages with an in-situ hyperspectral absorption-attenuation meter (acs, WETLabs inc., Fig. 1). HPLC pigment measurements and direct observations are also documenting phytoplankton species abundance changes. Three presentations at the Ocean Sciences 2006 will present the results from this work.

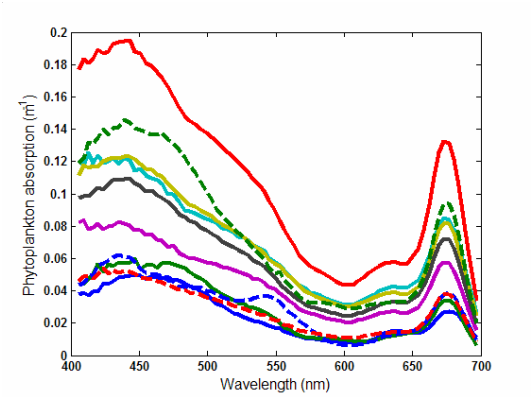


Figure 1 – Examples of phytoplankton absorption spectra obtained from in-situ measurements during monitoring cruises.

Final permits for use of the ^{14}C primary productivity measurements on the R/V Gulf Challenger have been obtained and measurements will begin this spring on the High Frequency cruises. Sampling for the *Alexandrium* species red tide phytoplankton will also start this spring on all cruises with samples being expressed to Don Anderson's group at the Woods Hole Oceanographic Institution (WHOI) for counting the next day. As such we will be part of the Northeast PSP collaborative monitoring effort with results being rapidly disseminated to coastal managers via an email mailing list.

Satellite Remote Sensing

Satellite algorithm development/validation – The ability of satellite based ocean color sensors to predict in water constituents depends on three main processes, 1) measurements of the top of the atmosphere radiances – *sensor characterization and calibration*, 2) removal of radiances from atmospheric sources – *atmospheric correction*, and 3) conversion of water leaving radiances into biogeochemically important properties – *bio-optical algorithms*. Sensor characterization and calibration is traditionally the responsibility of the federal agency responsible for the sensor, NASA for the SeaWiFS and MODIS sensors. The agency is also responsible for routine

atmospheric correction. More localized approaches to atmospheric correction for the Gulf of Maine are part of ongoing studies under other funded studies at UNH. Bio-optical algorithm validation and development are part of the work funded under this grant. Individual algorithms have different strengths and weaknesses both in the number and accuracy of the products they predict and in accommodating for errors in water leaving radiances introduced by the first two steps.

We are currently using the bio-optical data collected as part of the COOA cruises to investigate the use of three algorithms in the Gulf of Maine. 1) OC4v4 and OC3M the standard chlorophyll-a algorithm for operational SeaWiFS and MODIS sensors, respectively (O'Reilly et al. 2000), 2) GSM01 a semi-analytical algorithm capable of predicting chlorophyll-a, non-algal absorption, and particulate backscatter (Maritorena et al. 2002), and 3) QAA a quasi-analytical algorithm that returns similar properties to GSM01 (Lee et al. 2002). Efforts have focused on the MODIS/Aqua sensor as this data is readily available and will also include that from SeaWiFS. A three step process is being used in the algorithm investigation; 1) algorithm assessment with in-situ radiometric and biogeochemical values, 2) the ability of the algorithms to provide properties with satellite derived radiometric quantities, and 3) satellite to in-situ property comparisons (matchups).

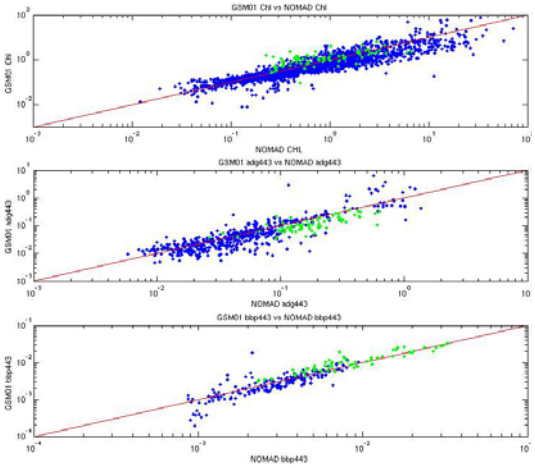
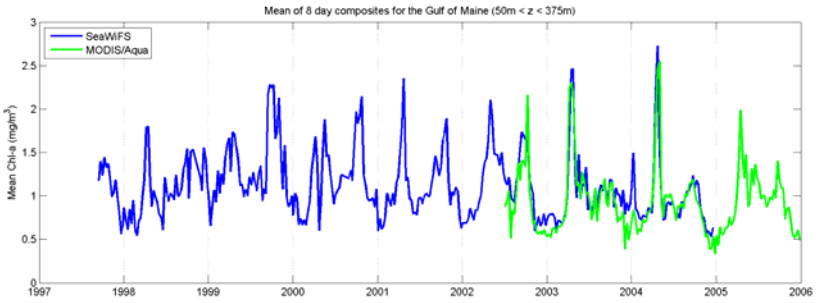


Figure 2 Example in situ algorithm assessment for GSM01. Data collected on the monitoring cruises (in green) can be compared to the global NOMAD dataset (blue) generated by NASA. The three panels represent the observed property on the x-axis against that predicted from the radiometric observations on the y-axis. The three panels represent; 1) top panel – chlorophyll-a (mgm^{-3}), 2) middle panel – non-algal absorption (m^{-1}), and 3) bottom panel – particulate backscattering (m^{-1}).

In situ algorithm assessment has demonstrated that OC4v4 over predicts chlorophyll-a concentrations in the Gulf of Maine in near coastal waters. In these waters non algal-absorption (CDOM and non-algal particles) affect reflectance ratios in a manner similar to chlorophyll-a. Initial results suggest that GSM01 and QAA, which can account for these non-algal optically important constituents, may be better able to predict phytoplankton abundances (e.g. Figure 2). These have the additional advantage of estimating properties other than chlorophyll-a alone. Both OC3M and QAA are able to function with MODIS/Aqua derived radiometric quantities but GSM01 often fails to converge on a solution. This is due to the increased sensitivity to radiometric errors of this semi-analytical algorithm which uses non-linear optimization. These errors derive in part from incorrect atmospheric correct and from errors associated with the sensor characterization. The former error is most noticeable in pixels where excess atmospheric correction results in blue water leaving radiances that are negative, a nonsensical result in natural waters. Also included are areas where incorrect atmospheric correction is sufficient to generate radiometric spectra that are outside those normally produced in ocean waters but with positive blue water leaving radiances. Satellite sensor problems are most noticeable in the banding in MODIS images. Both OC3M and QAA are less sensitive to satellite radiometric errors. Satellite to in-situ property comparisons are complicated by the need for cloud free conditions at the time of in-situ sampling which reduces the number of matchups. Continuing time-series

measurements are increasing the number of these matchups and a full comparison will be available for the upcoming year end report.

Near-realtime satellite data – The automated processing of MODIS/Aqua data and posting on the COOA data portal continues with 8 day composites of chlorophyll-a and sea surface temperature. Occasional lags in the availability of data have been associated with problems with data distribution from NASA.



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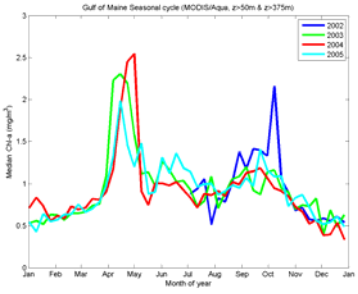

B

Figure 3 A) Time series of the mean chlorophyll-a concentration in the 8-day composites in the Gulf of Maine for waters between 50 and 375 meters. Data from both SeaWiFS and MODIS/Aqua satellites are shown. B) The same data for the years 2002-2005 from the MODIS/Aqua sensor highlighting the interannual differences between the timing and magnitude of events.

Historical data analysis/synthesis – To better understand the primary production in the western Gulf of Maine and the greater Gulf we have begun collating the information from the SeaWiFS and MODIS/Aqua sensors. This will allow us to generate mean fields to better understand forcings and also study interannual differences (Figure 3). These interannual differences can affect the time and magnitude of events such as the Spring and Fall phytoplankton increases which have been shown to have consequences in higher trophic levels (e.g.,Platt et al. 2003). Initial investigations into the timing of the Spring phytoplankton maximum have shown a general progression from north to south as has been demonstrated for nearby North Atlantic waters (Siegel et al. 2002) but also that it is moderated by oceanographic conditions (Figure 4).

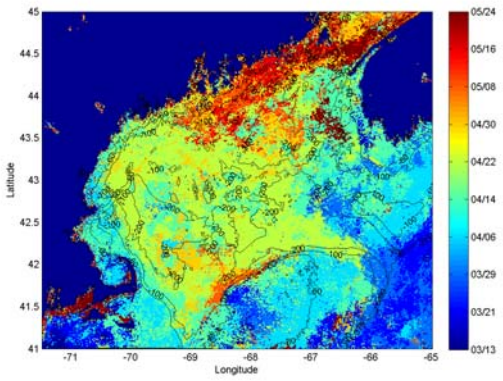

Figure 4 Timing of the mean Spring phytoplankton maximum based on an eight year average of the 8-day composites of chlorophyll-a as measured by the SeaWiFS sensor. The colors represent the date of the maximum as indicated by the colorbar to the right. Contours in black show the water depth in meters. This shows a general progression from south to north but this is moderated by the oceanographic conditions in the Gulf.

Summary

We are continuing to establish a sound basis for quantifying and understanding the variability in the primary productivity of the Gulf of Maine. We are continuing to assess the functioning of remote sensing algorithms in the complex optical conditions that exist in both the atmosphere and waters of the Gulf of Maine.

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Coastal Ocean Observation and Analysis Center - Coastal Buoy

J. Ru Morrison, Principal Investigator

Progress Report – January, 2006

Divers eye view of the Coastal Buoy just after redeployment and of the plethora of shells on the seabed at the Great Bay site

The Coastal Buoy project was initiated in 2004 with the goal of developing a reliable system for the monitoring of estuarine waters that provides data of direct use to people interested in the region. Included are those responsible for managing these regions, scientist study coastal processes, educators teaching students a variety of subjects, and commercial / recreational fishermen and boaters. The usefulness of such monitoring programs depends on the measurements made, their accuracy and reliability, as well as the quality of the data interpretation.

Specific objectives initially proposed were: (1) to develop a readily deployable buoy with a modular backbone, (2) to characterize coastal ecosystem components utilizing recently developed sensor and anti-fouling technology, (3) to provide real-time telemetry to shore by using the latest wireless technology, (4) to implement a shore-based data management system, and (5) to generate useable products through modeling and synthesis and consultation with interested partner groups especially the coastal management and education communities. The initial deployment date was anticipated to occur in April, 2005 after the loss of the winter ice cover.

Progress to date

Buoy deployment – The coastal buoy was deployed on April 28, 2005 in the Great Bay Estuary. It was recovered on August 9 and re-deployed on August 28, 2005 in Great Bay at 43.0715 ºN, 70.8678 ºW using the 19' Eastern that was used during recovery. The buoy was recovered for the season on November 30, 2005 to prevent ice damage. For the second deployment of 2005 the instruments were either swapped with fresh instruments or cleaned and recalibrated. A CDOM fluorometer (ECO-FLCDS, WetLabs Inc.) with a novel copper face plate as well as the standard shutter and wiper was part of the

redeployed sensor suite. The addition of the copper face plate greatly improved bio-fouling prevention.

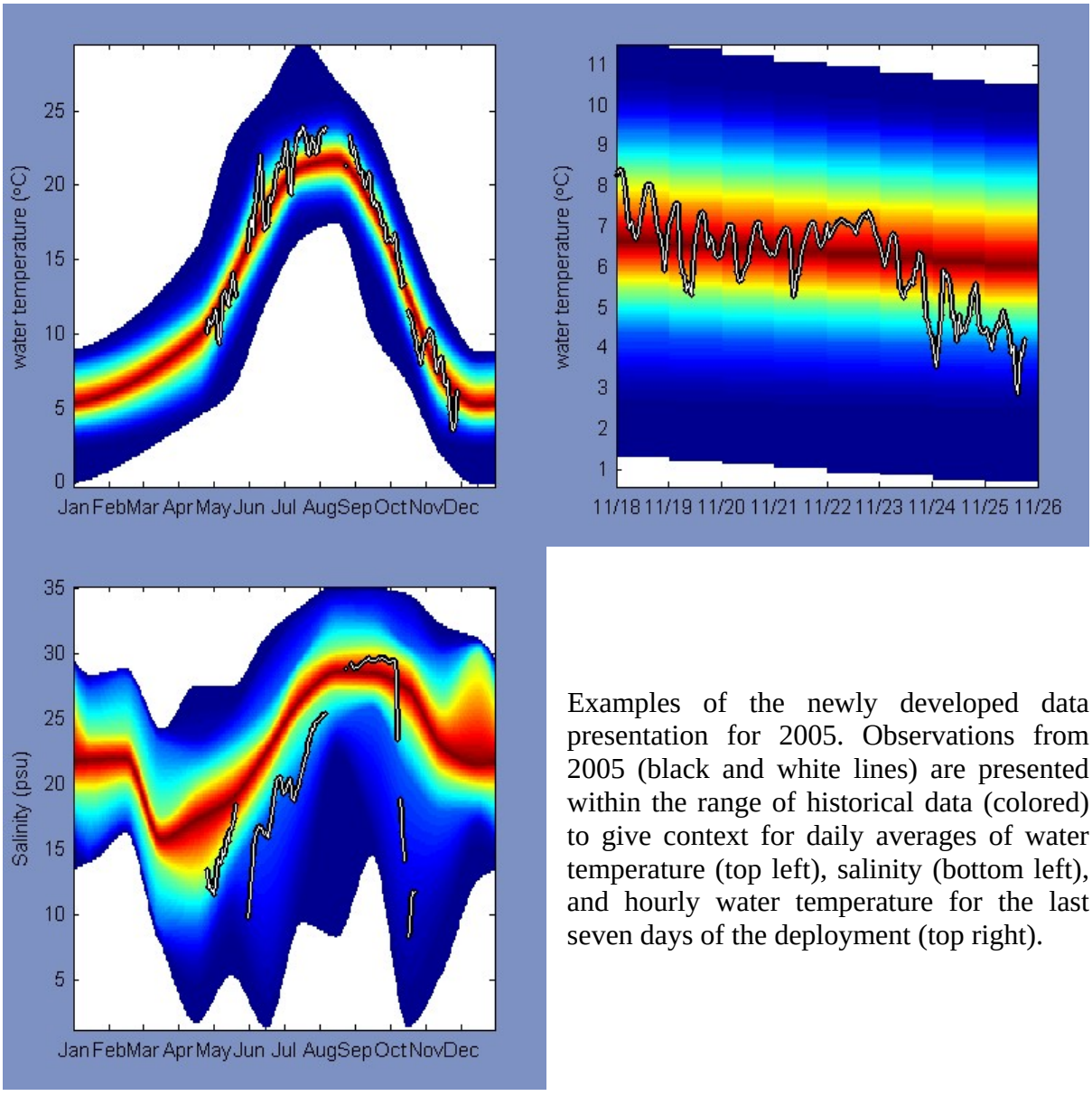
August 28, 2005 November 30, 2005

The CDOM fluorometer with the novel copper face plate just after deployment in August and after recovery at the end of November. The addition of the copper face plate increased bio-fouling prevention as can bee seen from the clear window o.

Redeployment of the system is scheduled for April, 2006 when the threat of ice damage is removed. A Nortek AWAC wave and current profile meter has been ordered and will be inegtrated into the system for deployement next year. An onboard processor (Nortek Internal Processor) will allow large amounts of the raw data to be processed on the AWAC into more concise estimates of wave and current properties. The unit will be mounted on a bottom frame with data transmitted to the Mooring System Manager via an umbilical cable that will run up one of the anchor chains. This will enable the data to be included in the near real-time data stream from the buoy.

Historical data analysis and current data visualization – An historic time series of quantiles were constructed using data collected from Great Bay from September,1973 – December, 1978 (Loder et al. 1983; Norrall et al. 1982) and January, 1989 – November, 2003 (GBCW 1990-2003; GBNERR 1989-2003). Samples were collected by three different organizations: University of New Hampshire, Great Bay National Estuarine Research Reserve, and the volunteer organization, Great Bay Coast Watch. Prior to 1995 samples were generally collected once a month throughout the year. In 1995, the Great Bay National Estuarine Research Reserve began using an instrument that sampled every 30 minutes and was repeatedly deployed for two week periods between April and December. Four different locations within Great Bay were included among the data used

to compile the quantile plots: Mid-Great Bay, Furber Straits, Adam's Point, and Sandy Point. Two of these sites, Adam's Point and Sandy Point, are shore-based sampling locations. We have also recovered data from 99 consecutive months of monitoring data similar to that collected by the Great Bay Research Reserve that spans 1973-1982. This data was partially available in reports at the Jackson Estuarine Lab but a full set of reports was not available. Thanks to Dr. Fred Short at the Jackson Lab an old 9 track computer storage tape was discovered. The data from this was recovered by a company in Texas and was found to be in an early version of the SAS statistical computing software. This was converted to the current version by the SAS company under the UNH site license agreement and the data exported as text files. The data have been quality checked, metadata written in consultation with the original investigators when necessary, and submitted to the NH-DES database for archiving and distribution. We are incorporating this data into that used to construct the quantile/percentile information.



Examples of the newly developed data presentation for 2005. Observations from 2005 (black and white lines) are presented within the range of historical data (colored) to give context for daily averages of water temperature (top left), salinity (bottom left), and hourly water temperature for the last seven days of the deployment (top right).

The quantile data were used to produce plots that allow current observations to be interpreted in the context of historical data. By taking monthly quantile information and interpolating it to provide daily information both annual and daily graphical representations were possible. Example figures for temperature and salinity are given above. In both figures historical observations were more likely to occur in dark red areas and less likely to occur in dark blue areas. The full range of the observed data is represented and the figures can be found at the buoy website http://www.cooa.unh.edu/buoydata/buoy.jsp. Details of this new approach to presenting ocean observing data and results from the project so far were presented at two talks at the Estuarine Research Federation 2005 conference in Norfolk, VA.

Summary

The buoy was deployed on time in April and recovered on the last day of November. The wealth of historical data in Great Bay has allowed new visualization techniques to be developed to facilitate interpretation of observing system data in an historical context. The validity of this graphical approach has been shown by the data collected in 2005. Communication with local stakeholders is continuing and is an important part of the work.

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NORRALL, T., A. MATHIESON, and C. PENNIMAN. 1982. Nutrient and Hydrographic Data for the Great Bay Estuarine System, New Hampshire - Maine; Part I: September 1973-December 1975. University of New Hampshire Marine Program and Jackson Estuarine Laboratory.

Coastal Carbon Time Series Project

Douglas Vandemark, Principal Investigator

Progress Report – January 2006

The goals of this Center subtask are to determine the extent of biological and freshwater control on coastal seawater CO_2 levels through both tower- and ship-based sampling strategies, and to obtain baseline measurements of carbon cycling that occurs within our coastal ecosystem. The work applies to several goals within the Center's mission. The first is to develop *in situ* and satellite remote sensing methods to the monitor atmospheric and oceanic carbon dioxide levels in coastal waters including the Gulf of Maine. The second is for COOA to lead the way in developing cost-effective methods to monitor and understand the evolving metabolism of coastal surface waters using CO2 and oxygen measurements. Phytoplankton productivity is fundamentally linked to the dynamics of these gases in the oceanic surface layer, and we are investigating the role that such gas measurements can play in implementing routine, continuous productivity observations.

Progress in the last 6-8 months has come in the area of data synthesis, and in the significant ongoing observational efforts taking place aboard the monthly Center cruises and at the coastal tower observing node of the Martha's Vineyard Observatory. Results from these efforts are cited below and have been presented at numerous conferences or in the literature.

Two robust time series have evolved from efforts of the past 2 years. The first is the MVCO tower time series of autonomous in situ ocean color alongside a comprehensive ancillary suite of bio-optical and physical data. Our real-time ocean color data are online at NASA/GSFC (http://aeronet.gsfc.nasa.gov/photo_db/MVCO.html) and these data are now processed under the new ocean color section of aerosol network website. We visited NASA this year to participate in the validation and testing of this processing software (Zibordi et al., 2006). Scientific results from the MVCO site are pointing out that the atmospheric correction to the optical MODIS satellite data is playing a large role in altering the ocean color data used to estimate chlorophyll and other pigments in the coastal waters of the Northwest Atlantic (Feng et al., 2006). The second time series under this task is two plus year measurement of surface seawater dissolved carbon dioxide and oxygen measurements collected as part of the COOA monthly sampling program. These data are generated with our underway system and are demonstrating the valuable information that one can gain on the seasonal and interannual variability of ecosystem dynamics associated with primary and secondary production (Vandemark et al., 2006, Salisbury et al., 2005 and 2006).

Finally, we continue to work with a new measurement technique related to the net ecosystem metabolism and its evolution via measurement of total dissolved gas pressure in surface waters. In summer and fall of 2005 we deployed a flo-thru version of the Pro Oceanus Inc. gas tension device. This is a sensor for measuring the total pressure of dissolved gas in seawater. When used in combination with precise oxygen measurements this tool allows us to track the partial pressure of nitrogen gas, an inert tracer of water

mass and air-sea mixing. These data are being collected and evaluated by UNH Master's student T. Brown to determine if this GTD technique can provide added quantitative measure of the controls (both physical and biological) on oxygen utilization such that we can effectively determine the net metabolism in the near surface waters by tracking CO2, oxygen and nitrogen levels. This work is being done in collaboration with Prof. Craig McNeil at the University of Rhode Island, a developer of this sensor. We expect a completed master's thesis by Sept. 2006 based on an extended time series of GTD data collected at the UNH Coastal Marine Laboratory Dec. 2005- April 2006.

Recent publications/presentations for the Center's CCTS task:

Feng H., D. Vandemark, R. Morrison, J. Campbell, H. Sosik, B. Holben and I. Slutsker, Assessment of satellite ocean color products near Martha's Vineyard Coastal Observatory (MVCO) in the northeast coast, AGU Ocean Sciences Meeting, Honolulu, 2006

Feng H., D. Vandemark, R. Morrison, J. Campbell, Heidi Sosik, B. Holben and I. Slutsker, Evaluation of satellite ocean color products near the Martha Vineyard Coastal Observatory (MVCO), NASA Ocean Color Research Team meeting, Newport, Rhode Island, 12-14 April, 2006.

Salisbury, J., D. Vandemark, C. Hunt, J. Campbell, J. R. Morrison, W. R. McGillis, A. Mahadevan, and H. Xue, Controls on Dissolved Inorganic Carbon (DIC) dynamics in coastal Gulf of Maine surface waters: The effects of discharge and biology; relationships to optical variables , Ocean Sciences Meeting, Honolulu, Feb. 2006.

Salisbury, J, D. Vandemark, C. Hunt, A. Mahadevan, F. Chai, J. W. Campbell, W. R. McGillis , Carbon cycling and Optics in the Gulf of Maine: Observations and modeling, Joint OCCC/NACP Coastal Ocean Carbon Workshop, Boulder CO, Sept. 2005.

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Zibordi, G., B. Holben, S. B. Hooker, F. Melin, J.-P. Berthon, I. Slutsker, D. Giles, D. Vandemark, H. Feng, K. Rutledge, G. Schuster and A.A. Mandoos, A network for standardized ocean color validation measurements, AGU EOS Transactions, in press.

Coupled Biological-Physical Modeling

Jeffrey Runge, Principal Investigator

Progress Report – January, 2006

I. Milestones for period in review:

1. **Engage post-doctoral associate to conduct simulation experiments investigating fate of larval cod under variable wind regimes (*August 05*)**

   The primary objective of the period under review was to initiate and guide the work the post-doctoral research associate, Dr. Martin Huret, in collaboration with Dr. C. Chen at SMAST, University of Massachusetts, Dartmouth. Dr. Huret, who worked previously at CNRS and IFREMER in France on coupled biophysical models arrived in mid-July. Contracting details were worked out with the SMAST office and he started working in August on the Finite Volume Coastal Ocean Model (FVCOM) applied to the Gulf of Maine in Dr. Chen's lab.

   Dr. Huret works out of Chen's lab at SMAST. He spent the first three months learning the FVCOM and discussing the simulation experiment protocols with Dr. Runge during regular meetings at UNH. Between December 05 and March 06, he has made great progress in application of the FVCOM to particle-based simulations of larval distributions from spawning areas in the Gulf of Maine. The simulations show strong connectivity among spawning grounds and juvenile nursery areas in the western Gulf of Maine, with potential application in management of protected areas.

   The initial results were presented in seminars at U Mass Dartmouth and UNH, at a meeting of New Hampshire fishermen and at the GoMOOS session at the Maine Fisherman's Forum.

2. **Conduct third workshop and complete first phase of western Gulf of Maine Inshore Fisheries-Ecosystems project in collaboration with NAMA. (*August 05*)**

   The third workshop was conducted in May, earlier than anticipated, at the Urban Forestry Center in Portsmouth. A progress report describing results of the Inshore Fisheries-Ecosystems project was submitted to the UNH Vice President's Office Outreach Scholar Program in October. Information sheets describing food web interactions and cod spawning and nursery areas in the western Gulf of Maine are in preparation for distribution to fishermen and members of the New England Fisheries Management Council.

3. **Complete 2005 annual survey of zooplankton/ichtyoplankton biomass and composition (*December 05*)**

   The survey was completed in December. Bongo samples were taken along a transect in Ipswich Bay for ichthyoplankton (herring) and zooplankton distribution across the shallow shelf and deeper Scantum Basin. This completes the 2005 annual survey, which also included transects in June during the main period of cod spawning in Ipswich Bay.

These surveys serve two purposes: (1) observations of larval cod and herring distribution in relation to the downstream circulation, for validation of coupled physical biological modeling and (2) contribute to a test of the hypothesis that *Calanus finmarchicus* is found in high abundances in Scantum Basin, which represents a cul-de-sac in the inshore circulation of deeper Gulf of Maine water.

4. **Complete simulation experiments investigating fate of larval shrimp under variable wind regimes (M.S. student thesis) (*February 06*)**
   This study constitutes the Master's thesis project of Michael Bates, Department of Earth Sciences. The transport success of shrimp larvae from hatching areas off the coasts of Maine and New Hampshire is examined with the use of a particle tracking model coupled to the FVCOM climatological model with realistic wind fields for given years. A sensitivity study was conducted, showing the most successful transport of larvae to inshore nursery areas occurs during along shore winds when larvae are located in an intermediate depth layer centered on 15-20 m. M. Bates is now in the process of writing his thesis for defense in fall, 2006. A publication for submission to a scientific journal is in preparation.

II. Additional achievements

5. RARGOM workshop report

The workshop report for the RARGOM theme session on modeling needs related to the regional observing system in the Gulf of Maine was completed in December, 2005. The report contains short articles/ abstracts by plenary speakers, meeting reports on the management-research connection in relation to the observing system, data needs and critical issues for models in the context of the observing system and visions and roles of a regional modeling center, and recommendations and research priorities. The report can be accessed on the RARGOM web site (www.rargom.org).

6. COOA modeling meeting.

A meeting of COOA personnel involved in modeling activities was held at UNH in on January 20, 2006. Discussion topics were COOA's modeling role, the modeling components and modeling on the COOA web page. COOA's function can be to take the middle ground between research and management needs. It can facilitate development of models to interpret observing data and explore them for applications with users through a process of information exchange. One suggestion is to invite one manager to each modeling meeting and focus on identifying intersections between models and the manager's decision needs. Another suggestion for information exchange include a rotating seminar series on how to do ecosystem based management and what information is needed to flow into this process.

7. PULSE final report

In a related project that leverages COOA, the final report of the cooperative partnership between UNH and New Hampshire fishermen to monitor seasonal and interannual variation in zooplankton off the New Hampshire coast was completed in March, 2006. The final report can be found on the Pulse website (www.pulse.unh.edu).

8. Submission of paper to Science

J. Runge is a coauthor on a research article submitted to Science magazine in February. The article discusses how climate-induced changes in freshwater input from the Labrador Sea during the 1990s led to abrupt and persistent changes in the Gulf of Maine ecosystem involving phytoplankton, zooplankton, herring and right whales.

III. Commentary on actual budget expenditures in relation to anticipated budget expenditures.

The subcontract to SMAST, Univ. Massachusetts, Dartmouth, commenced in July, 2006. Funds in the 2005 fiscal year will be used to fund the postodoctoral research position presently occupied by Dr M. Huret until June, 2008.

IV. Summary of deliverables, Aug 05- Mar 06

Pershing, A., C. Greene, E. Durbin, E. Head, S. Hakkinen, D. Mountain, J. Jossi, J. Runge, et al. in review. Remote forcing of marine ecosystem dynamics in the Northwest Atlantic. Science.

Huret, M., J. A. Runge, C. Chen, G. Cowles, Q. Xu and J. M. Pringle. In prep. Dispersal modeling of fish early life stages: Application to Atlantic cod in the western Gulf of Maine. Mar. Ecol. Prog. Ser.

Runge, J.A. and R.J. Jones. 2006. PULSE: A Cooperative Partnership for Coastal Ocean Ecosystem Monitoring in the Gulf of Maine. Final Report. Northeast Consortium Cooperative Research projects.

Runge, J. A. and E. Braasch (eds.). 2005. Modeling needs related to the regional observing system in the Gulf of Maine. RARGOM Report 05-1. 79 pp.

Runge, J.A. and H. Deese. 2005. A collaboration between UNH and NAMA (Northwest Atlantic Marine Alliance) for the application of coastal ocean observing science to the conservation and stewardship of the Gulf of Maine inshore fisheries. Final report. Vice President for Research and Public Service Discretionary Research and Outreach Scholarship Fund. 66 pp.

FleetLink Project

Clearwater Instrumentation, Inc. and Woods Hole Oceanographic Institution

Progress Report – June 30, 2006

Project Title: FleetLink: Coastal Ocean Observing from Commercial Fishing and Research Vessels

Project Objectives: Information from U.S. coastal waters for meteorological and oceanographic conditions and commercial fishing operations are needed by resource managers and regulators, the ocean research community, and commercial fishermen. The widespread temporal/spatial distribution of commercial fishing vessels and coastal research vessels makes them ideal platforms from which to gather basic information for coastal monitoring, modeling, and prediction. The objective of this project has been to use fishing vessels and coastal research vessels as platforms for the FleetLink meteorological and oceanographic data system, and to transmit the data in real-time to a server on shore where the data are processed and made publicly available on the web.

Work Completed

We continue to maintain and upgrade FleetLink on the six vessels currently collecting data. Below is a list of significant events from July 2005-January 2006.

- We attended monthly COOA All Hands meetings at UNH from July 2005-January 2006.
- Over 10 maintenance trips were made to FleetLink vessels for maintenance and upgrading.
- In the fall of 2005 there were small fires onboard both the *F/V Adventurer* and the *F/V Lori B.* We were able to save both FleetLink systems and they are currently operational.
- In January 2006 FleetLink was removed from the *F/V Susan & Caitlyn.* Owner Craig Pendleton no longer needed FleetLink on his boat since he is selling it. This gave us enough spare parts to install a system onboard the *R/V Connecticut.*
- In February 2006 we will switch our Iridium satellite service to NAL Research. This is required since our original vendor stopped offering Iridium transmission services.

Table 1: Data transmission days from July 2005 to January 2006.

Date	R/V Gulf Challenger	R/V Tioga	F/V Adventurer	F/V Lori B	F/V Kris N Kev	F/V Susan & Caitlyn	Monthly total
July-05	8	13	5	7	10	5	48
August-05	15	19	4	14	14	1	67
September-05	21	24	0	29	13	0	87
October-05	23	29	1	0	9	0	62
November-05	11	0	7	0	10	2	30
December-05	0	0	0	0	0	0	0
January-06	6	0	24	0	0	0	30
Annual vessel total	84	85	41	50	56	8	324

Sum of data transmission days from July 2005 to January 2006 for all boats = 324.

A review of the web site statistics shows that much of the access (about 45% of the "hits") is from web crawlers, such as Google. The overall number of daily "hits" averages about 90, exclusive of the web crawlers, or about 2700 per month. (*Information provided by Robert Groman at WHOI.)*

Work Scheduled

- In July 2006 we will make a trip to Avery Point, CT to install the new Fleetlink system onboard the *R/V Connecticut.*
- We are looking into a seventh installation of FleetLink on the new UCONN 36' research vessel the *R/V Lowell Weicker.*
- This summer we will change the settings in Calliope onboard the *F/V Lori B* to output the wind speed in knots, instead of meters/ second, and the temperature in Fahrenheit.
- We are building more sea surface temperature (SST) probes to install on all vessels currently without probes. Currently the *R/V Gulf Challenger* and the *R/V Tioga* have SST probes. We will install a probe onboard the *R/V Connecticut* and the other fishing vessels.
- We will continue to upgrade Calliope as new versions of the software become available and modify FleetLink software as necessary as well as maintain the required calibration standards of our data collecting instruments.
- We will continue to monitor data quality and perform regular maintenance on automated procedures to maintain data accuracy.

Summary

We have supported the operational integrity of the FleetLink system by regularly maintaining sensors and hardware, responding to equipment malfunction, and updating software to meet changes in other components of the FleetLink system including Calliope and Iridium communications. This has allowed FleetLink to provide a steady stream of valuable real time data of the Gulf of Maine's weather conditions to the research community and vessel operators alike. We have provided participants with an Iridium internet connection which many of the fishermen use to download current local weather from the NOAA website, as well as an email system. The onboard computer provides a display of all the basic weather conditions and strip charts which plot live data, and data are sorted and posted to the website for public access. These are a few of the services Fleetlink is providing, and it has potential to provide even more. This year three new vessels have inquired about a FleetLink installation. While the bulk of our efforts are focused on maximizing our existing systems, this interest suggests that some effort be applied to expanding FleetLink to other vessels.

WebCOAST: Data and Information Management

Annette Schloss, Principal Investigator

Progress Report – January 2006

Data collections – Data collections are now updated either manually (such as Satellite Data or Great Bay Coast Watch) or automatically by way of a web crawler (Cruise Data). We met with Jim Irish and his group to work out a plan for adding the near-real time data from the Open Ocean Aquaculture buoy to WebCOAST.

Web Metrics: Aug 1 2005 – February 1 2006

Page hits all COOA: 24,178

Percentage of hits by domain:

com	41%
net	21%
edu	10%
gov	1%
other	27%

WebCOAST served 7870 data files (28 Gigabytes) in 2005.

Site additions, improvements, modifications – We refined the cruise data web crawler and added capability to automatically link to any browse images and make them viewable over the web. We worked with Ru Morrison to provide an automatically updated web page for the Coastal Buoy. As new data are posted (about every hour), the system generates an updated web page.

Hardware – We purchased a DLT tape backup system that is now in operation. RAID disks are backed up to tape whenever new data are added.

Education and Outreach Activities - We completed a final version of the *"Gulf of Maine Monitoring Programs"* searchable data catalog in collaboration with the Gulf of Maine Council on the Marine Environment (GOMC). The system was demonstrated at the Council's annual meeting in December, 2005 and released publicly shortly thereafter (Council Home Page: http://www.gulfofmaine.org/ ; Monitoring Programs Home Page: http://gomc.sr.unh.edu/index.jsp) We continue to work with the Council to fine-tune the system to meet their needs.

The phytoplankton chapter (Title: *"When is Dinner Served? Predicting the Spring Phytoplankton Bloom in the Gulf of Maine"*) for the Earth Exploration Toolbook (EET) has been reviewed by NASA and after some minor revisions, will be accepted as a NASA-approved educational resource.

Denise worked with Amy Cline to create two promotional flyers for COOA.

Presentations – Annette Schloss presented a poster entitled *"The Gulf of Maine Ocean Data Partnership – building a region-wide information system from the bottom up"* at the annual American Geophysical Union (AGU) meeting in San Francisco, CA, December 2005. The poster highlighted the work of the GOMODP as a grass-roots organization that aids members in posting their data online and preparing metadata for the Global Change Master Directory. The poster and a flyer were designed for use by the Partnership as promotional materials beyond the AGU venue.

Meetings Attended – Annette Schloss attended the Gulf of Maine Ocean Data Partnership metadata training workshop, October 19-20, 2005 in Portland, ME.

Annette Schloss attended the Federation of Earth Science Information Partners winter meeting, January 3-5, 2006, Washington, DC. She presented a poster about WebCOAST, our data, outreach and education programs.

Annette Schloss participated in several GOMODP telecons and helped edit the Technical Committee's technical assistance documents.

Committee/Working Group Memberships

Gulf of Maine Data Partnership, Technical Committee – Annette Schloss (Bill Armstrong will participate if needed)

COTS Data Assembly and Aggregation Committee – Annette Schloss

Federation of Earth Science Information Partners, Standing Committee for Community Engagement – Annette Schloss

Federation of Earth Science Information Partners, Standing Committee for Education – Denise Blaha

Federation of Earth Science Information Partners, Standing Committee for Technology – Bill Armstrong

Education and Outreach

Amy Holt Cline, Coordinator

Progress Report – January 2006

August 2005

- Attended annual meeting of the National Science Teachers Association to promote EET Chapter. (This was actually in April; it was mistakenly stated as August in Milestones)
- Maintained ongoing collaboration with the COSEE-OS (Centers for Ocean Science Education Excellence – Ocean Systems)

September 2005

- Gave invited talk at the Marine Technology Society Meeting in Washington DC to present how we have been running our Ocean Observing Educator Institutes sponsored by GoMOOS and the UNH Coastal Observing Center
- Continued ongoing work with the Seacoast Science Center, Rye, NH to complete Ocean Observing Exhibit

October 2005

- Presented Ocean Observing materials at the Massachusetts Marine Educators Meeting in Boston, MA
- Attended the ORION Education and Public Outreach Committee meeting in Washington DC.
- Continued ongoing work with the Seacoast Science Center, Rye, NH to complete Ocean Observing Exhibit

November 2005

- Continued ongoing with the Seacoast Science Center, Rye, NH to complete Ocean Observing Exhibit
- Continued ongoing collaboration with the COSEE-OS (Centers for Ocean Science Education Excellence – Ocean Systems)

December 2005

- Helped facilitate a concept mapping meeting with the COSEE-OS (Centers for Ocean Science Education Excellence – Ocean Systems) with educational researchers and ocean scientists Brunswick, ME
- Attended the ORION Education and Public Outreach Committee meeting in Washington DC.

January 2006

- Continued ongoing work with the Seacoast Science Center, Rye, NH to complete Ocean Observing Exhibit
- Attended Gulf of Maine Marine Educators Planning Meeting to host the 2007 National Marine Educators Conference in Maine.